

[Claims]

1. A control method of an AC motor comprising:

an electric power converter to output an electric power to an AC motor, and

5 a current control section to control the output current of the electric power converter based on a difference signal of an output current detection signal of a current command signal and the electric power converter, wherein

when the AC motor is in the free run condition, the current
10 control is conducted by making the current command signal forcibly zero so that the current of the AC motor is made zero; and on the base of the output voltage command signal which is calculated by using the current control section output, the amplitude and phase and angular velocity of the residual
15 voltage of the AC motor are found.

2. A control method of the AC motor according to Claim 1, wherein, when the amplitude and phase and angular velocity of the residual voltage of the AC motor are found on
20 the base of the output voltage command signal, a signal holding means is provided, and from the addition value of the phase command signal just before the free run of the AC motor, and the phase signal of the output voltage command signal, the amplitude and phase and angular velocity of the residual
25 voltage are found.

3. A control method of the AC motor in which an

arbitrary electric power is outputted to the AC motor by the electric power converter; the current to be supplied to the motor is detected by a current detection circuit; the current control circuit controls so that the given current command
5 coincides with the current detection value detected by the current detection circuit; and the switching of the electric power converter is determined from the voltage command outputted from the current control circuit, the control method of the AC motor is characterized in that: a start control
10 circuit controls so that the electric power converter is normally operated at the start, and the speed of the AC motor in the free run condition is estimated by a speed estimation circuit.

15 4. A control method of the AC motor according to Claim 3, wherein the start control circuit forcibly makes the current command zero, and calculates the voltage command by which the current detection value is made zero, by the current control circuit, and by the time change of the voltage command, the
20 speed estimation circuit estimates the speed of the AC motor.

5. A control method of the AC motor according to Claim 3, wherein the start control circuit forcibly makes the current command zero, and calculates the voltage command by which the
25 current detection value is made zero, by the current control circuit, and when its voltage level is lower than the set voltage level, after the DC current command of set level is

applied for the set time period from zero, the current command is forcibly made zero again, by the current control circuit, the voltage command by which the current detection value is made zero, is calculated, and the speed estimation circuit
5 estimates the speed of the AC motor.

6. A control method of the AC motor according to any one of Claim 3, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit,
10 the voltage command by which the current detection value is made zero, is calculated, and when its voltage level is lower than the set voltage level, after the DC current control command of the set level is applied for a set time period from zero, the current command is forcibly made zero again, and by the
15 current control circuit, even when the voltage command by which the current detection value is made zero, is calculated, when its voltage level is lower than the set voltage level, the speed estimation circuit estimates that the AC motor is stopped.

20 7. A control method of the AC motor according to any one of Claims 1 to 6, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, the voltage command by which the current detection value is made zero, is calculated, and by the time change of
25 the voltage command, the speed estimation circuit starts the AC motor by making the estimated speed of the AC motor and the amplitude and phase of the voltage command as the initial value.

8. A control method of the AC motor according to any one of Claims 1 to 6, wherein the start control circuit forcibly makes the current command zero, and by the current control
5 circuit, the voltage command by which the current detection value is made zero, is calculated, and by the time change of the voltage command, when the speed estimation circuit starts the AC motor by making the estimated speed of the AC motor and the amplitude and phase of the voltage command as the initial
10 value, the amplitude of the voltage command outputted from the electric power converter is gradually increased until it becomes the voltage level corresponding to the normal induced voltage to the speed of the AC motor.

15 9. A control apparatus of the AC motor, which has: an electric power converter to output an arbitrary electric power to the AC motor; current detection circuit to detect the current supplied to the motor; and current control circuit which controls so that the given current command coincides with
20 the current detection value detected by the current detection circuit, and in which the switching of the electric power converter is determined from the voltage command outputted from the current control circuit, the control apparatus of the AC motor is characterized in that it has the start control circuit,
25 and the speed estimation circuit to estimate the speed of the AC motor in the free run condition.

10. A control apparatus of the AC motor according to Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, calculates the voltage command by which the current detection value is made zero, and by the time change of the voltage command, the speed estimation circuit estimates the speed of the AC motor.

11. A control apparatus of the AC motor according to Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, calculates the voltage command by which the current detection value is made zero, and when its voltage level is lower than the set voltage level, after the DC current command of the set level is applied from zero for set time period, the current command is forcibly made zero again, and by the current control circuit, the voltage command by which the current detection value is made zero, is calculated, and the speed estimation circuit estimates the speed of the AC motor.

12. A control apparatus of the AC motor according to Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, calculates the voltage command by which the current detection value is made zero, and when its voltage level is lower than the set voltage level, after the DC current command of the set level is applied from zero for set time period from zero, the current command is forcibly made zero again, and by the current

control circuit, even when the voltage command by which the current detection value is made zero, is calculated, when its voltage level is lower than the set voltage level, the speed estimation circuit estimates that the AC motor is stopped.

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13. A control apparatus of the AC motor according to Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, calculates the voltage command by which the current detection value is made zero, and by the time change of the voltage command, the speed estimation circuit starts the AC motor by making the estimated speed of the AC motor and the amplitude and phase of the voltage command as the initial value.

15 14. A control apparatus of the AC motor according to Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, calculates the voltage command by which the current detection value is made zero, and by the time change of the voltage command, 20 when the speed estimation circuit starts the AC motor by making the estimated speed of the AC motor and the amplitude and phase of the voltage command as the initial value, the amplitude of the voltage command outputted from the electric power converter is gradually increased until it becomes the voltage level 25 corresponding to the normal induced voltage to the speed of the AC motor.

15. A control method of the AC motor according to Claim 3, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, calculates the voltage command by which the current detection value is made zero, and when the voltage command is larger than the set voltage level, by the time change of the phase of the voltage command, the speed estimation circuit estimates the speed of the AC motor, and as the initial value when the electric power converter is started, the amplitude and phase of the voltage command and the frequency corresponding to the speed estimation value of the AC motor are set, and it is started.

16. A control method of the AC motor which is characterized in that: it has an electric power converter to output the electric power to the AC motor, and the current control section by which the output current of the electric power converter is controlled, according to the difference signal of the current command signal and the output current detection signal of the electric power converter, in which, when the AC motor is in the free run condition, the arbitrary DC current is supplied to the AC motor for a set time period, and the frequency component appeared in the output current detection signal of the electric power converter is detected, and from this frequency component, the speed of the AC motor is estimated.

17. A control method of the AC motor according to Claim

3, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, the voltage command by which the current detection value is made zero, is calculated, and when its voltage level is lower than the set
5 voltage level, the DC current command of the set level or the DC voltage command of the set level is applied for a set time period from zero, and the speed estimation circuit detects the frequency component appeared in the current detection value, and estimates this frequency component as the speed of the AC
10 motor, and as the initial value when the electric power converter is started, the frequency corresponding to the speed estimation value of the AC motor is set, and it is started.

18. A control method of the AC motor according to Claim
15 3, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, the voltage command by which the current detection value is made zero, is calculated, and when the voltage command is lower than the set voltage level, the current command is changed from
20 zero to the DC current command value of the set level, and supplied for a set time period, and after that, the sign and the amplitude of the current command are changed, and applied for a set time period. The control method of the AC motor which is characterized in that, at this time, the speed estimation
25 circuit detects the frequency component appeared in the current detection value, and estimates this frequency component as the speed of the AC motor, and as the initial value when

the electric power converter is started, the frequency corresponding to the speed estimation value of the A motor is set, and it is started.

5 19. A control method of the AC motor according to Claim
3, wherein the start control circuit forcibly makes the
current command zero, and by the current control circuit, the
voltage command by which the current detection value is made
10 zero, is calculated, and when the voltage command is lower than
the set voltage level, the current control is stopped, and the
DC current command is applied for a set time period in the
arbitrary direction, after that, the arbitrary amplitude
current command is given in the direction in which the phase
is changed by 180° from the command direction of the DC voltage,
15 and the current control is conducted again for a set time period.
The control method of the AC motor which is characterized in
that, at this time, the speed estimation circuit detects the
frequency component appeared in the current detection value,
and estimates this frequency component as the speed of the AC
20 motor, and as the initial value when the electric power
converter is started, the frequency corresponding to the speed
estimation value of the AC motor is set, and it is started.

 20. A control apparatus of the AC motor according to
25 Claim 9, wherein the start control circuit forcibly makes the
current command zero, and by the current control circuit, the
voltage command by which the current detection value is made

zero, is calculated, and when the voltage command is larger than the set voltage level, by the time change of the phase of the voltage command, the speed estimation circuit estimates the speed of the AC motor, and as the initial value when the electric power converter is started, the amplitude and phase of the voltage command and the frequency corresponding to the speed estimation value of the AC motor are set, and it is started.

21. A control apparatus of the AC motor according to Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, the voltage command by which the current detection value is made zero, is calculated, and when its voltage level is lower than the set voltage level, the DC current command of the set level or the DC voltage command of the set level is applied for a set time period from zero, and the speed estimation circuit detects the frequency component appeared in the current detection value, and estimates this frequency component as the speed of the AC motor, and as the initial value when the electric power converter is started, the frequency corresponding to the speed estimation value of the AC motor is set, and it is started.

22. A control apparatus of the AC motor according to Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, the voltage command by which the current detection value is made

zero, is calculated, and when the voltage command is lower than the set voltage level, the current command is changed from zero to the DC current command value of the set level, and supplied for a set time period, and after that, the sign and the amplitude
5 of the current command are changed, and applied for a set time period. The control apparatus of the AC motor which is characterized in that, at this time, the speed estimation circuit detects the frequency component appeared in the current detection value, and estimates this frequency component as the
10 speed of the AC motor, and as the initial value when the electric power converter is started, the frequency corresponding to the speed estimation value of the A motor is set, and it is started.

23. A control apparatus of the AC motor according to
15 Claim 9, wherein the start control circuit forcibly makes the current command zero, and by the current control circuit, the voltage command by which the current detection value is made zero, is calculated, and when the voltage command is lower than the set voltage level, the current control is stopped, and the
20 DC voltage command is applied for a set time period in the arbitrary direction, after that, the arbitrary amplitude current command is given in the direction in which the phase is changed by 180° from the command direction of the DC voltage, and the current control is conducted again for a set time period.
25 The control apparatus of the AC motor which is characterized in that, at this time, the speed estimation circuit detects the frequency component appeared in the current detection value,

and estimates this frequency component as the speed of the AC motor, and as the initial value when the electric power converter is started, the frequency corresponding to the speed estimation value of the AC motor is set, and it is started.